Response to comments by Referee #2 (anonymous) on "Examining the relationship between intermediate scale soil moisture and terrestrial evaporation within a semi-arid grassland" by Jana et al.

We greatly appreciate the review comments and thank the reviewer for their effort. We have addressed all of the comments and present our responses below.

The review comments are in regular typeface, while all responses are in italics and indented paragraphs.

The authors present an interesting case study comparing three different commonly used evaporation schemes versus a COSMOS soil moisture probe. The results illustrate reasonable statistical comparisons between the methods between the 25th and 75th quantile, but breakdown outside these ranges. I agree with the authors assessment of the challenges comparing the state variable of soil moisture with evaporation flux, particularly given the spatial scale differences of the observations. The work here is a valuable contribution to continue advancing the utility of the COSMOS soil moisture probes with applications in surface energy balance or land atmospheric coupling.

The paper is well written and suitable for HESS. Below are some recommendations to improve the manuscript.

We thank the anonymous reviewer for their positive comments on the manuscript.

Comments:
Pg 2. L2. Is it land surface evaporation or evapotranspiration? The symbol ET is a bit confusing if it only refers to evaporation only.

We have removed all instances of the term "ET" in the manuscript. Following the convention of (Kalma et al. 2008) the term "evaporation" is used to represent land surface evaporation, which comprises evaporation from soil and canopy, as well as transpiration from vegetation.

Kalma, J.D., McVicar, T.R., & McCabe, M.F. (2008). Estimating land surface evaporation: A review of methods using remotely sensed surface temperture data. Surveys in Geophysics, 29, 421-469

Pp 6. L11-19. Is the COSMOS data the same as presented by Hawdon 2014? That is, it is corrected for water vapor, geomagnetic latitude, pressure in the same way? Please specify.

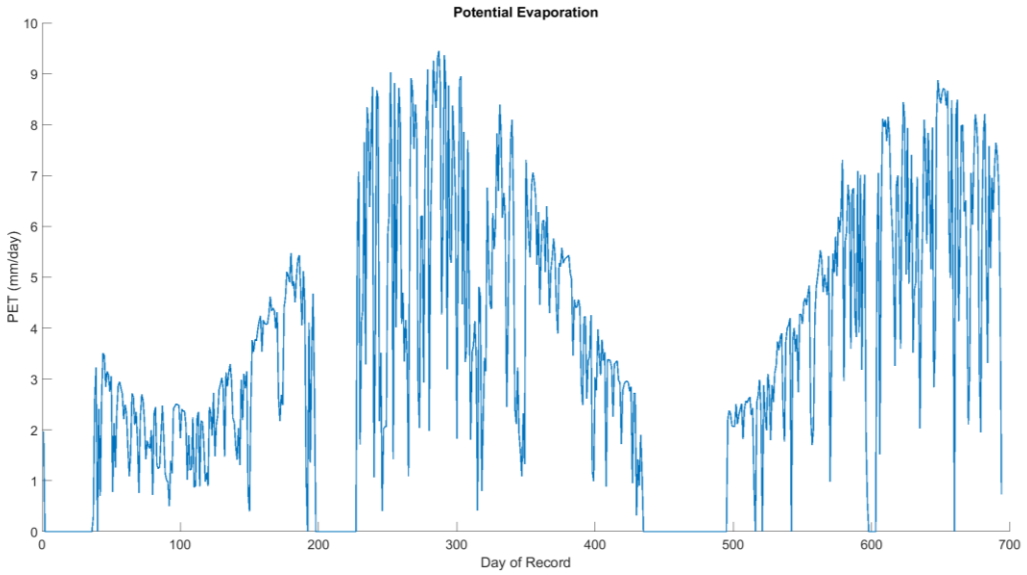
Yes, the data is the same as presented by Hawdon et al., 2014. We have updated the text to clarify this point.

P 8 L24. The selection of sampling periods seems a bit arbitrary. Why not use seasons or PET to separate periods?

We agree that the sampling periods are somewhat arbitrary. However, we felt that analyzing periods of distinctly different hydrological behavior, as described in the text for the four chosen sub-periods, would provide a better understanding of the correspondence between the soil moisture and evaporation signals under different situations. In regards to the reviewer's suggestion on a

more formal allocation of analysis periods, we analyzed the relationship based on partitioning the time series according to seasons. As stated in the text, the results were similar to those obtained by partitioning by behavior in that while the SEBS model performed better than the others, no single model output corresponded well with the soil moisture across all seasons.

The PET for the site (computed using meteorological tower data) follows a distinctly seasonal trend (see figure below). As such, partitioning based on seasons can be deemed analogous to using PET.



L 10 L31. I am not what is might by this sentence, the soil moisture profile becomes heterogeneous during periods when it is disconnected to the atmosphere? Can you please explain more or show an example?

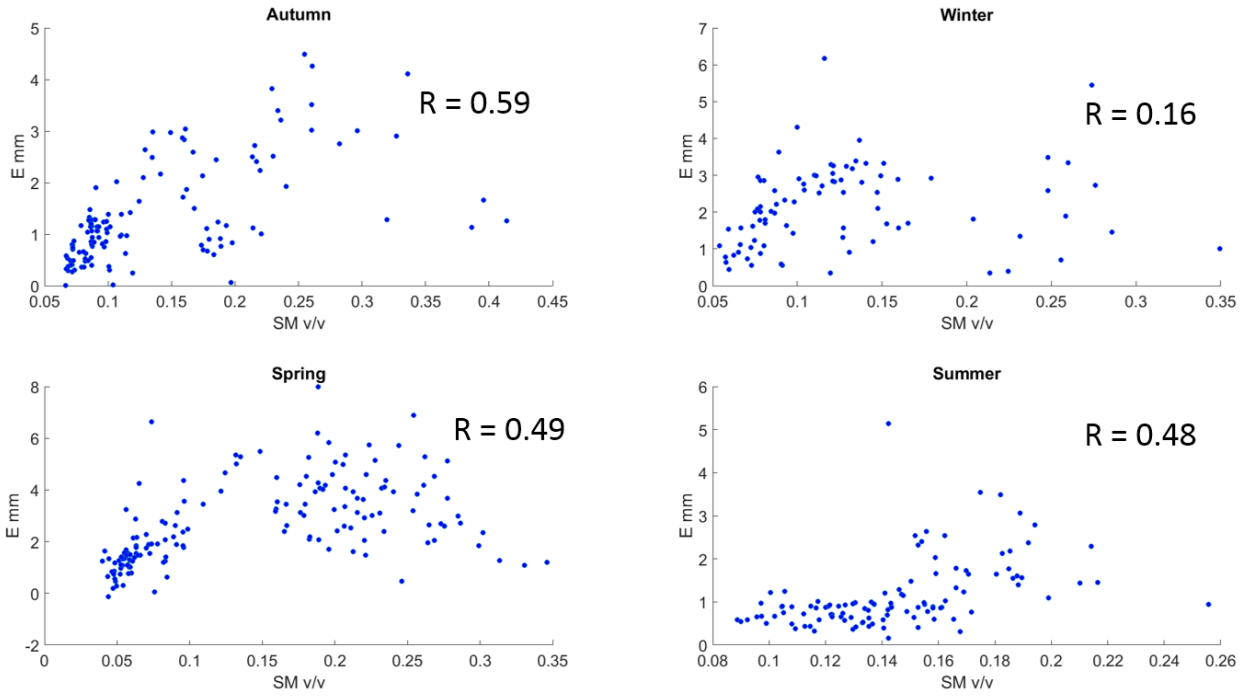
The soil moisture profile is said to become heterogeneous since the surface and deeper layer moistures are driven by different processes, and are not linked to each other. We have updated the text with some more explanation for the term. The section now reads thus:

"However, there were also long periods with no rainfall events. Combined with the higher temperatures of summer, this leads to greater non-monotonic variations in the soil moisture signature, thus creating a disconnect with the evaporation patterns. There are more switches between moisture-constrained and energy-constrained conditions during this season. It has been demonstrated previously that the occurrence of hot and dry periods leads to de-coupling of soil moisture and evaporation (Pollacco and Mohanty 2012). The soil moisture profile in such situations becomes heterogeneous in that the process driving the surface soil moisture variability (mainly soil evaporation) no longer influences the deeper layer soil moisture variability (mainly due to transpiration). Further explanation of this de-coupling process can be found in Pollacco and Mohanty (2012)."

Pg 11 L13 and Figure 2a. The comparison between soil moisture and ET should be further partitioned by PET amount or season.

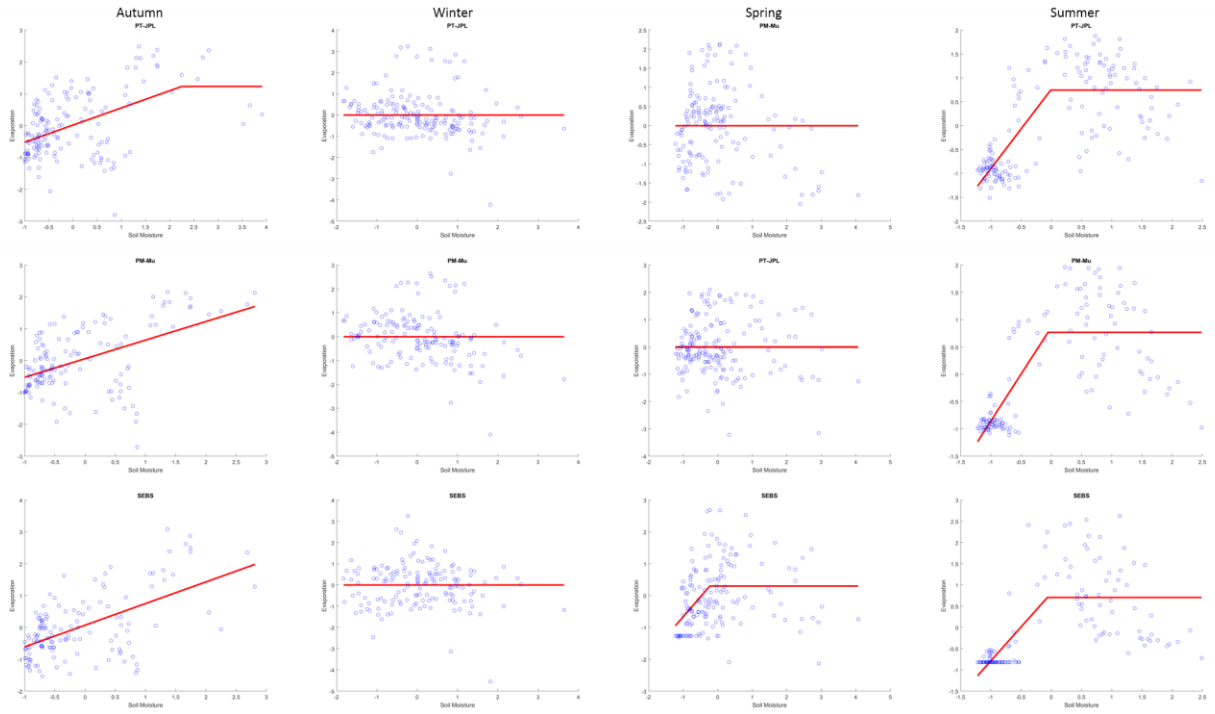
We did plot the scatter of soil moisture v. evaporation after partitioning by seasons (please see figure below). However, it was felt that such a comparison did not add much new information apart

from showing that the relationships between the two quantities were different in different seasons. Since we already present this difference in the other plots where we analyze the relationship based on seasons, we decided not to include this figure and comparison in the manuscript.



Following the simple broken stick type model in Rodriguez-Iturbe 2001 and Laio 2001, I would expect there to be a family of curves with the plateau being near ETmax for each set of curves. I suggest the authors organize the data by season or PET groups and replot (with either colors or different symbols). For such a simple dryland grassland site I would expect the broken stick kind of model to represent this data well. The direct correspondence between soil moisture and ET may become more clear instead of just the distributions. If so things like the soil moisture threshold at which ET is reduced may become clear from the datasets.

This is an excellent suggestion, and we thank the reviewer for it. Based on this suggestion, we performed piece-wise linear regression analyses on the seasonally-partitioned data. The plots are given below:



Each row in the figure corresponds to a model (PT-JPL, PM-Mu, and SEBS), while each column corresponds to a season (autumn, winter, spring, summer). Unfortunately, in this particular case there was not much useful information that could be gleaned from the plots. Some information regarding the soil moisture threshold where the evaporation rate starts decreasing can be discerned for all three models only in the summer. The plots for the other seasons are largely non-informative. However, it should be borne in mind that this data spans a relatively short period (under 2 years). It is possible that a longer data record over many more years could result in a more distinct behavior as expected by the reviewer. For the present study, we decided against including this analysis in the manuscript.

Rodriguez-Iturbe, I., A. Porporato, F. Laio, and L. Ridolfi (2001), Plants in watercontrolled ecosystems: active role in hydrologic processes and response to water stress - I. Scope and general outline, Adv. Water Resour., 24(7), 695-705.
Laio, F., A. Porporato, L. Ridolfi, and I. Rodriguez-Iturbe (2001), Plants in watercontrolled ecosystems: active role in hydrologic processes and response to water stress - II. Probabilistic soil moisture dynamics, Adv. Water Resour., 24(7), 707-723.

Comments on conclusions: The challenge of relating energy balance models like SEBS to soil moisture has some interesting applications. For example, in agriculture many research and private industry groups are using such routines from satellites and drones to schedule irrigation. However, the soil moisture may be more unconstrained in this case than can be suitable for reasonable management of irrigation amounts and timing. The authors could potentially comment on this application given the findings of the paper.

This is certainly an interesting line of inquiry and one that our group is actively exploring via the use of UAVs in agricultural systems. However, as you suggest, we suspect that such approaches may not be particularly useful for irrigation scheduling. Rather, the techniques we are investigating

look to explore the spatial variability in crop systems, relating this back to spatially distributed areas of moisture stress or even over-application. While we anticipate that there should still be signs of coupling in these environments, the managed nature of the problem may make these links harder to disentangle. Given that we are dealing with quite a different problem in this particular semi-arid landscape example, we have not explored these interesting ideas in the present manuscript, but it is certainly an aspect worth future investigation.